THE BONE BRECCIA OF BOOTLEGGER SINK, YORK COUNTY, PA.

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Introduction

Bootlegger Sink has been known for many years. It is described by Stone (1953).

Preliminary collection of breccia from Bootlegger Sink by one of us (Hamilton) in October, 1963, produced the remains of two rodents, the thirteen-lined ground squirrel (*Citellus tridecemlineatus*) and the northern bog lemming (*Synaptomys borealis*), both now extinct in the area. Both species were present in the Late Pleistocene New Paris No. 4 local fauna of Bedford County, Pennsylvania (Guilday, Martin and McCrady, 1964).

A second field trip was made in November, 1963. The results of the two trips are discussed in this paper.

We wish to thank Mr. Jerry Frederick, Miss Monica Rectenwald, and Mrs. Rita Hamilton for able assistance in the field; Dr. T. J. Weisman, Gulf Research and Development Co. laboratories, Harmarville, Pa. (carbon^{14} dating); Mr. Joseph R. Ryan, Harbison Walker Refractories (spectrochemical analysis); Dr. Paul S. Martin, Geochronology Laboratories, University of Arizona [pollen analysis of samples of loam that had been trapped in the breccia (results were negative)]; Mr. Neil D. Richmond, Curator of Amphibians and Reptiles, Carnegie Museum (amphibians and reptiles); Dr. Nell B. Causey, University of Arkansas (millipedes); Dr. J. Kenneth Doutt, Curator, and Miss Caroline A. Heppenstall, Assistant Curator, Section of Mammals, Carnegie Museum (caribou). Fig. 1 is by Miss Monica Rectenwald; figs. 2 and 4 by Donald P. Tanner, and fig. 3 by Richard W. Lang. Research was conducted under National Science Foundation grant no. 20868. The initials CM identify Carnegie Museum catalogue numbers.

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Bootlegger Sink, latitude 40° 01′ 00″ N., longitude 76° 43′ 30″ W., altitude 350 feet, is one-quarter mile east of Emigsville, Manchester Township, York County, southeastern Pennsylvania. The sink is on a gently sloping hillside approximately one-half mile west and 50 feet higher than Codorus Creek, the master stream of the area. From this point, Codorus Creek flows four miles in a northeasterly direction to join the Susquehanna River some 50 miles west of its mouth at Chesapeake Bay. As Codorus Creek approaches the Susquehanna River it becomes intrenched and meandering. At its mouth near Codorus Furnace it has entrenched for some 200 feet. The general land surface rises gently to the north from Bootlegger Sink to the south bank of the Susquehanna River so that the sink is only 100 feet above the Susquehanna River level.

Physiographically, Bootegger Sink lies within the Limestone Valley Section of the Piedmont Province. This broad, fertile, intensely farmed valley some ten miles wide lies between the Piedmont Highlands to the east and the Triassic Lowlands to the west, north of the Pigeon Hills.

York County is over 80 per cent cleared land, most of it in cultivation for three hundred years. Soils range in color from brown through orange to reddish. They are composed principally of residue from limestone removed by solution. They are classified in the Hagerstown series and are among the most valuable farming soils of the state.

Geologically, the sinkhole is formed in the Vintage dolomite of lower Cambrian age. It lies just east of the Triassic Lowlands belt in a region of contorted and faulted limestones and quartzites.

The climate is temperate. Observations at Hanover, York County, 20 miles southwest of the sink in the same physiographic province indicate a frost-free period of 173 days, mean January temperature 33.1 F., mean July temperature 75.8 F., with an average annual precipitation of 40.07 inches.

In its primitive condition, the area was covered with an oak forest, probably dominated by white oak (*Quercus alba*), but the original forest cover was removed so long ago that its exact make-up is in doubt. This portion of the state is well within the Carolinian life zone, sharing closer affinities with the biota of the Coastal Plain than with the mountainous areas of the State.

The breccia occurred as a ledge 1.2 meters above the present active talus (fig. 1). Varying from 0.13 meter to 1.2 meters thick, it projected 0.15 meter to 3.0 meters from the sinkhole walls. It represents the remnant of a surface-derived talus that once filled the sink to that point. This

Fig. 1 Interior of Bootlegger Sink, York County, Pennsylvania. Entrance directly above climbers. Note breccia ledge. Dotted lines indicate areas sampled by Carnegie Museum field parties in 1963. After photo by Mohr, *in* Stone, 1953.

talus may have formed rather abruptly (although the faunal assemblage appears to be a mixed one), or at least at a faster rate than it could be removed by the stream now flowing across the floor of Bootlegger Sink. Or, possibly, a talus formed on some projecting ledge which eventually was overloaded and collapsed into the bottom of the sinkhole carrying with it all of the talus except that which was cemented to the sinkhole wall.

The bone breccia was composed of a matrix of angular, irregular blocks of unweathered dolomite (80 per cent) derived from the sinkhole walls, of rounded, well-weathered limonitic sandstone pebbles (about 10 per cent, averaging 10-13 cm. in diameter), and another 10 per cent of brown, sandy, unconsolidated loam, all bound together with travertine, 10 cm. thick in many spots. Intermingled with the rock components, in the loam inclusions as well as imbedded in travertine, were lumps of wood charcoal up to 25 mm. square. An occasional fragment of quartzite and weathered argalite also was present. Intermingled in both the unconsolidated loam and in the travertine itself were animal bones, terrestrial snail shells, and a few calcified millipedes. The breccia ledge was covered with a thin coating of weathered, light-gray flowstone, but a freshly broken surface was colorful. The sandstone varied from a bright, sandy yellow to a bright, brick-red which contrasted with the blue-black of the dolomite and the glaring white of the numerous *Triodopsis* shells. The travertine was light tan in color.

The entire breccia deposit is about 8 square meters. Approximately 1.5 square meters were removed by wedging and dynamiting. These were reduced by hammer and chisel, separating the breccia along contacts between the travertine and the inclusions. Charcoal for dating was collected from freshly broken surfaces. Loam inclusions were collected for pollen analysis. When bone was exposed, the final cleaning was done with fine chisels and grinding and vibrating tools. Fortunately, many of the loam inclusions were fossiliferous, and were washed to recover such minute items as insectivore teeth.

Fluorine Analysis of Material

In order to test the fauna for contemporaneity 19 samples of bones and teeth representing 17 vertebrate species were submitted to Joseph R. Ryan of Garber Research Center, Harbison Walker Refractories Company, for spectrochemical analysis. (All samples were prepared from items broken out of breccia blocks. All were intimately associated.) The

assumption was made that percentage of fluorine was positively correlated with age. Results are presented in fig. 2. The fluorine content of the flowstone was 0.78 per cent. This is lower than that of any of the enclosed bones, but higher than the one snail (*Triodopsis albolabris*) shell tested, 0.30 per cent.

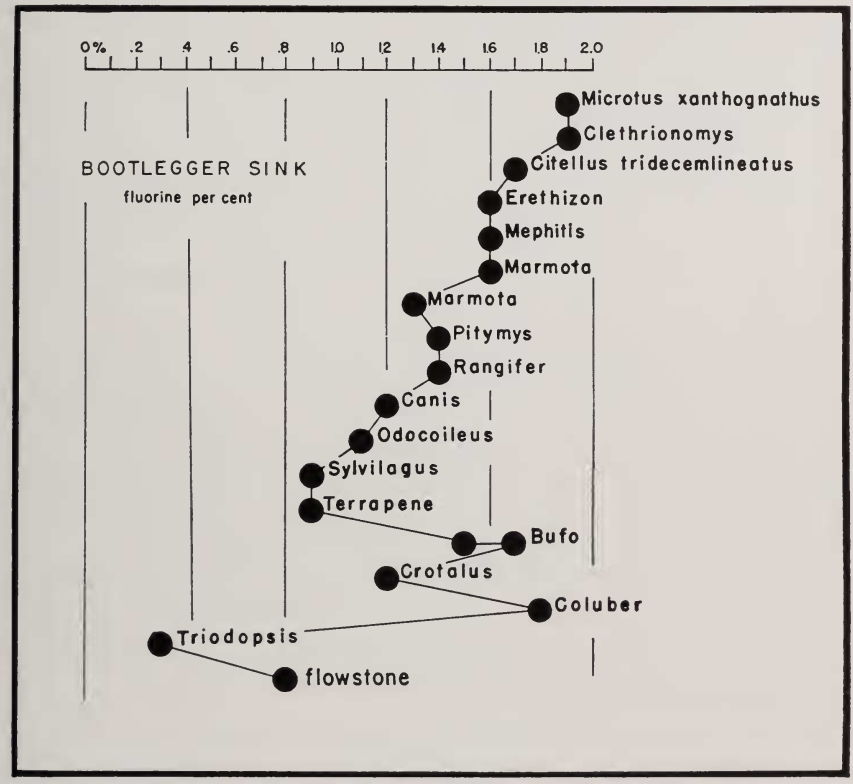

Fig. 2 Fluorine content of samples from Bootlegger Sink breccia. See text for explanation. Note two *Bufo* samples.

There is a wide range of values from rabbit (*Sylvilagus* 0.88 per cent) and box turtle (*Terrapene* 0.91 per cent) up to red-backed vole (*Clethrionomys* 1.93 per cent), and yellow-cheeked vole (*Microtus xanthognathus* 1.87 per cent). The values are evenly distributed, which would imply continuous deposition over a long span of time.

In addition to elapsed time, the percentage of fluorine appears to be

related to bone density or porosity. Bone taken from the mandible of a woodchuck (*Marmota monax*) ran 1.60 per cent, while enamel and dentine from the incisor in the same mandible was only 1.29 per cent. Bone from the mandible of a pine vole (*Pitymys pinetorum*) tested 1.44 per cent, while that from the articular surface of a caribou (*Rangifer*) phalanx tested 1.36 per cent. *Pitymys,* a southern form, and *Rangifer,* a northern form, are ecologically incompatible. *Rangifer* undoubtedly predated *Pitymys* in the deposit, and, all things being equal, its fluorine value should have been significantly higher. That it was not may be related to bone density. A sample of deer (*Odocoileus virginianus*) bone, taken from a phalanx, as in the case of the caribou, tested lower (1.12 per cent *Odocoileus,* 1.36 per cent *Rangifer*). These bone samples were of equal density and the results agree with the modern distribution of these animals. *Rangifer,* being the more boreal of the two, would be expected to be older in Bootlegger Sink, hence higher in fluorine content.

Variations in bone porosity may have affected the values of the reptile and amphibian bone samples as well. Dense bone from the carapace of the box turtle (*Terrapene*) was low (0.91 per cent) while porous toad (*Bufo*) limb bones and vertebrae of rattlesnake (*Crotalus*) and black snake (*Coluber*) were much higher. Binford (1965) tested samples of limb bones and vertebrae of snowshoe hare (*Lepus americanus*) from different levels of New Paris Sinkhole No. 4 and found that they behaved as two populations. The cancellous vertebral bone was consistently higher in radioactive thorium than was the denser limb bone material. Since thorium is acquired from the ground water, as is the fluorine, differential absorption depending upon bone porosity would seem to be common to both.

The effects of varying rates of ground-water circulation, of temperature changes, both seasonal and major-climatic, and the local effects of an erratic flowstone cover doubtless contribute to the rate of fluorine absorption.

Despite these disturbing possibilities, it is encouraging to note that the three species of mammals highest in fluorine content are known to have been associated in late Pleistocene times: New Paris No. 4, Pennsylvania, and Natural Chimneys, Virginia (Guilday, 1962). None occur at these sites today. The range of the yellow-cheeked vole (*M. xanthognathus*) has retreated, following deglaciation, 1200 miles to the northwest (fig. 4, map 1A); that of the thirteen-lined ground squirrel (*Citellus tridecemlineatus*) (fig. 4, map 1B) at least 500 miles to the west. The

red-backed vole (*Clethrionomys*) is still found in northern Pennsylvania and extends south along the mountain ridges.

The three species with the lowest percentage of fluorine, the box turtle (*Terrapene carolina*), the rabbit (*Sylvilagus*) (fig. 4, map 4), and the deer (*Odocoileus*) are temperate species that all inhabit the area today.

Because of the many uncontrolled factors that might influence the fluorine content, the percentages given here are not necessarily a direct function of time. But the general picture seems to indicate continuous deposition from a boreal to a temperature climate. The carbon[14] date, which provides a minimum date for the formation of the breccia, is well within Recent times, 3,722± 200 years (Before Present). (Sample No. 10-29-4, Gulf Research and Development Co. laboratory, Harmarville, Pa.)

FAUNAL LIST, BOOTLEGGER SINK

DIPLOPODA identified by Nell B. Causey

Conotyla, ?species	millipede
? *Apheloria,* species	millipede

GASTROPODA

Triodopsis albolabris	snail

AMPHIBIA identified by Neil D. Richmond

Order Caudata—salamander

unidentified salamander, 3 vertebrae

Order Salientia

Family Pelobatidae

Scaphiopus	spadefoot toad, 1 vertebra

Family Bufonidae

Bufo americanus	American toad, 1 ilium
Bufo woodhouseii fowleri	Fowler's toad, 1 ilium, 1 fronto-parietal

Family Hylidae

Hyla, ?species	tree frog

Family Ranidae

Rana pipiens	leopard frog

REPTILIA identified by Neil D. Richmond

Order Chelonia

Family Testudinidae

Terrapene carolina	box turtle

Order Serpentes
Family Colubridae

Carphophis cf. *amoena*	worm snake	
Coluber cf. *constrictor*	black racer	
Lampropeltis calligaster rhombomaculata	mole snake	
Thamnophis cf. *sirtalus*	garter snake	

Family Crotalidae

Crotalus cf. *horridus*	rattlesnake	
Ancistrodon cf. *contortrix*	copperhead	

MAMMALIA

		Minimum number of individuals
	Order Insectivora	
	Family Soricidae	
Sorex cf. *cinereus*	masked shrew	1
Sorex arcticus	Arctic shrew	1
Microsorex hoyi	pygmy shrew	1
Blarina brevicauda	short-tailed shrew	2
Cryptotis parva	least shrew	1
	Family Talpidae	
Parascalops breweri	hairy-tailed mole	1
Condylura cristata	star-nosed mole	1
	Order Chiroptera	
	Family Vespertilionidae	
Myotis cf. *keenii*	Keen's bat	8
Myotis cf. *lucifugus* or *keenii*	little brown bat	8
Pipistrellus cf. *subflavus*	pipistrelle	2
Eptesicus cf. *grandis*	big brown bat	1
Plecotus sp.	long-eared bat	3
	Order Lagomorpha	
	Family Leporidae	
Sylvilagus cf. *floridanus*	cottontail rabbit	1
Sylvilagus sp.	cottontail rabbit	4
	Order Rodentia	
	Family Sciuridae	
Tamias striatus	chipmunk	4
Marmota monax	woodchuck	3
Citellus tridecemlineatus	thirteen-lined ground squirrel	1
Sciurus sp.	gray or fox squirrel	1
Tamiasciurus hudsonicus	red squirrel	1
Glaucomys volans	southern flying squirrel	1
Glaucomys sabrinus	northern flying squirrel	1

		Minimum number of individuals
	Family Cricetidae	
Peromyscus cf. *leucopus*	white-footed mouse	1
Peromyscus cf. *maniculatus*	deer mouse	1
Peromyscus sp.		6
Clethrionomys gapperi	red-backed vole	10
Microtus pennsylvanicus	meadow vole	5
Microtus chrotorrhinus	rock vole	1
Microtus xanthognathus	yellow-cheeked vole	3
Microtus sp.		2
Pitymys pinetorum	pine vole	1
Synaptomys borealis	northern bog lemming	3
	Family Zapodidae	
Napaeozapus insignis	woodland jumping mouse	2
	Family Erethizontidae	
Erethizon dorsatum	porcupine	4
	Order Carnivora Family Canidae	
Canis sp.	dog or small wolf	1
Vulpes sp.	red fox	1
	Family Mustelidae	
Mustela sp.	weasel	1
Mephitis mephitis	striped skunk	5
Lutra canadensis	otter	1
	Order Artiodactyla Family Cervidae	
Odocoileus virginianus	white-tailed deer	1
Rangifer cf. *tarandus*	caribou	1

ANNOTATED LIST, BOOTLEGGER SINK LOCAL FAUNA

AMPHIBIANS AND REPTILES

One left ilium of a toad-sized salientian (CM 7954, fig. 3) cannot be identified. The high ilial crest and the position of the ilial prominence (much farther back than in *Bufo*) make a unique combination. It is figured with no additional comment. If more specimens are recovered it may be well worth describing as a new form.

The presence of the box turtle (*Terrapene carolina*) is an indication of temperate conditions, incompatible with the boreal elements of the fauna. Its absence from the extensive boreal fauna of New Paris No. 4,

plus the low fluorine value for the Bootlegger Sink specimen, would indicate a relatively late date for its inclusion even though it was almost encased in travertine.

The mole snake (*Lampropeltis calligaster rhombomaculata*) no longer occurs as far north as Pennsylvania (fig. 4, map 1C). This species and the long-eared bat (*Plecotus*) probably date from the Hypsithermal Interval. All other species occur at least as far north as the site today.

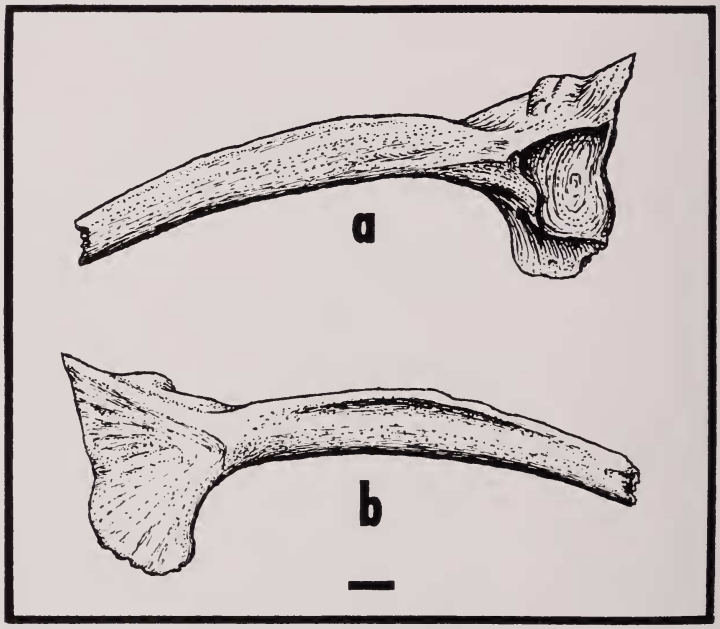

Fig. 3 Salientia, ?species. CM 7954. Left ilium. a. External view. b. Internal view. Bar = 2 mm.

MAMMALS

Order Insectivora
Family Soricidae

Sorex cf. *cinereus* Kerr—Masked shrew

MATERIAL: CM 7925-27. Two left, 1 right mandible.

REMARKS: The identification remains provisional because of the possibility of confusion with *S. longirostris*. *Sorex longirostris* has never been recorded north of Maryland (Hall and Kelson, 1959), but the presence of *Plecotus* in the Bootlegger Sink local fauna makes it probable that other southern forms might be present as well.

Sorex arcticus Kerr—Arctic shrew

MATERIAL: CM 7921. One left mandible.

REMARKS: Confined to the Canadian life zone today (fig. 4, map 2A), this shrew ranged as far south as Natural Chimneys, Virginia, and Robinson Cave, Tennessee (McCrady and Schmidt, 1963), during the late Pleistocene.

Microsorex hoyi (Baird)—Pygmy shrew

MATERIAL: CM 7922. One partial skull; 1 left, 1 right mandible.

REMARKS: Although this nominally northern shrew does occur as far south as Washington, D. C. (Bailey, 1923), there is only one modern record for Pennsylvania, (Roslund, 1951, p. 40). It was common in the late Pleistocene New Paris No. 4 local fauna.

Blarina brevicauda (Say)—Short-tailed shrew

MATERIAL: CM 7924. One P^4, 1 M^1; 1 left, 2 right mandibles; 1 I_1; 1 humerus.

Cryptotis parva (Say)—Least shrew

MATERIAL: CM 7923. One mandible (sacrificed for spectrochemical analysis); 1 left maxilla.

REMARKS: A field-inhabiting form of southern affinities. (fig. 4, map 2B). Present in the area today, *Cryptotis parva* was probably not a member of the boreal fauna. The material proved to be inadequate for spectrochemical analysis.

Family Talpidae

Parascalops breweri (Bachman)—Hairy-tailed mole

MATERIAL: CM 7961. One left M_1, M_2; 1 right radius.

REMARKS: The hairy-tailed mole does not inhabit the Piedmont Province today. It is common in the Ridge and Valley Province, the Appalachian Plateau, and the Pocono Mountains. *Scalopus aquaticus*, the common mole of the eastern seaboard area and York County, was not present in the deposit.

Condylura cristata (Linnaeus)—Star-nosed mole

MATERIAL: CM 7962. One left, 1 right lower molar; 1 right humerus; 1 left tibia.

Order Chiroptera

Family Vespertilionidae

Myotis cf. *keenii* (Merriam)—Keen's bat

MATERIAL: CM 7929-7934, CM 7936-7940, CM 7946-7947. One partial skull; 2 right maxillae; 2 left, 8 right mandibles.

Myotis cf. *lucifugus* or *keenii*—Little brown bat

MATERIAL: CM 7935, CM 7941-7943, CM 7945, CM 7955-7957. Eight left, 3 right fragmentary mandibles.

Pipistrellus cf. *subflavus* (F. Cuvier)—Pipistrelle

MATERIAL: CM 7958-7960. One left maxilla; 2 right mandibles.

Eptesicus cf. *grandis* (Brown)—Brown's brown bat

MATERIAL: CM 7963. One partial right mandible, P_4-M_3; 1 upper canine.

Plecotus sp.—Long-eared bat

MATERIAL: CM 7944, CM 7964. Three left, 1 right partial mandibles; 1 M_1. (Two of the mandible fragments, 1 left, 1 right, were sacrificed for spectrochemical analysis, but the sample proved inadequate.)

REMARKS: This is the third known locality for *Plecotus* north of its present range in the Appalachians. (fig. 4, map 3B). [*Plecotus sp.*, Frankstown Cave, Blair County, Pennsylvania (Guilday, 1961), and *Plecotus alleganiensis* (Gidley and Gazin, 1938) from Cumberland Cave, Maryland, cannot be dated and may be pre-Wisconsin age]. The Bootlegger Sink specimens are post-Wisconsin and probably date to the Hypsithermal Interval. All other species recovered from this deposit with the exception of the mole snake (fig. 4, map 1C) occur either at the site or north of it today.

Order Lagomorpha
Family Leporidae

Sylvilagus cf. *floridanus* (J. A. Allen)—Cottontail rabbit

MATERIAL: CM 8003. One right frontal.

REMARKS: Identification based upon characteristic pre- and post-orbital processes.

Sylvilagus, ?sp.–probably *floridanus or transitionalis*

MATERIAL: CM 8004. One right mandible, 1 right ascending ramus of mandible with coranoid process.

cf. *Sylvilagus*, ?species

MATERIAL: CM 8005. Four left, 1 right partial mandible; 3 fragmentary right innominates; 5 cervical, 3 thoracic vertebrae; 1 left, 1 right humerus; 3 calcania; 1 navicular; fragments of femur, radius, ulna, metatarsus, maxillae.

Order Rodentia
Family Sciuridae

Tamias striatus (Linnaeus)—Chipmunk

MATERIAL: CM 7899, CM 7976, CM 7979. One left, 4 right partial mandibles; 1 left maxilla P^4-M^2; 1 partial skull, no dentition.

Marmota monax Linnaeus—Woodchuck

MATERIAL: CM 8002. Three right mandibles.

REMARKS: Portions of one mandible were sacrificed for spectrochemical analysis.

Citellus tridecemlineatus (Mitchell)—Thirteen-lined ground squirrel

MATERIAL: CM 7894. CM 7973. One right maxilla, P^4-M^3; 1 left, 1 right M_3. CM 7920. One partial right mandible, P_4-M_2.

REMARKS: Now confined to the prairie of central North America except for a feral colony in northwestern Pennsylvania (Richmond and Roslund, 1949) (fig. 4, map 1B), this ground squirrel was widely distributed in the east during late Pleistocene times. It has been recovered from New Paris No. 4, Pennsylvania; Cumberland Cave, Maryland; Natural Chimneys, Virginia; and Robinson Cave, Tennessee.

Sciurus, ?sp. —Gray or fox squirrel

MATERIAL: CM 7992. One right M^3, badly worn.

Tamiasciurus hudsonicus (Erxleben)—Red squirrel

MATERIAL: CM 7974. One left M^2; 1 left premaxilla with incisor; 1 left, 1 right frontal bone.

Glaucomys volans (Linnaeus)—Southern flying squirrel

MATERIAL: CM 7980. One left mandible, P_4-M_1.

Glaucomys sabrinus (Shaw)—Northern flying squirrel

MATERIAL: CM 7977. One right M_2.

REMARKS: Referred to *G. sabrinus* on the basis of its large size. It agrees with New Paris No. 4 referred specimens.

Family Cricetidae

Peromyscus cf. *leucopus* (Rafinesque)—White-footed mouse

MATERIAL: CM 7972. One left M_1.

Peromyscus cf. *maniculatus* (Wagner)—Deer mouse

MATERIAL: CM 7971. One right maxilla with M^1.

Peromyscus, ?species

MATERIAL: CM 7969, CM 7970, CM 7973. Two left, 6 right mandibles; 1 left, 2 right maxillae; 17 molars.

Clethrionomys gapperi (Vigors)—Red-backed vole

MATERIAL: CM 7914-7917, CM 8010. Two partial skulls; 1 left, 1 right maxilla; 4 left, 10 right mandibles and/or M_1's.

REMARKS: This was the commonest mammal in the deposit. The red-backed vole no longer occurs in York County although it is common in cool mountain forests throughout the state and occurs in South Mountain in neighboring Lancaster County (Roberts and Early, 1952: 52).

Microtus pennsylvanicus (Ord)—Meadow vole

MATERIAL: CM 7905-7909, CM 7911. Five partial skulls; 1 left, 1 right maxilla.

Microtus chrotorrhinus (Miller)—Rock vole

MATERIAL: CM 7901. One partial skull, left M^3 missing, otherwise full dentition.

REMARKS: This vole occurs as a boreal relict as far south as the peaks of the Great Smoky Mountains. It has been taken in a few localities in northern Pennsylvania but does not occur in York County today (Roslund, 1951). It was apparently much more widespread during the boreal climate of the late Pleistocene. It was common in the New Paris No. 4, Pennsylvania, local fauna and also has been recovered from the Natural Chimneys, Virginia, local fauna.

Microtus xanthognathus (Leach)—Yellow-cheeked vole

MATERIAL: CM 7902-7904. Three right mandibles; 1 right M^3; 1 left innominate; 1 tibia.

REMARKS: This vole ranges throughout the Hudsonian life zone of western Canada from Churchill, Manitoba (1200 mi. northwest of Bootlegger Sink) north and west to Alaska (fig. 4, map 1A). This is the third known late Pleistocene record of this species in the Appalachians. It is known from New Paris No. 4, Pennsylvania, (over 300 individuals) and from Natural Chimneys, Virginia.

Pitymys pinetorum (La Conte)—Pine Vole

MATERIAL: CM 7913. One left, 1 right mandible.

REMARKS: The commonest microtine at the site today.

Synaptomys borealis (Richardson)—Northern bog lemming

MATERIAL: CM 7892, CM 7893, CM 7918, CM 7965. Two right, 1 left mandible; 1 right M_1.

REMARKS: This boreal rodent, found over a large portion of forested Canada, enters the United States only in Minnesota and the northern Appalachians as far south as New Hampshire's White Mountains. It occurred as far south as Natural Chimneys, Virginia, during the late Pleistocene and also has been recorded from Robinson Cave, Tennessee, Cumberland Cave, Maryland, and New Paris No. 4, Pennsylvania.

Family Zapodidae

Napaeozapus insignis (Miller)—Woodland jumping mouse

MATERIAL: CM 7982-7983. One left maxilla with M^1 and M^3; 1 right M_1, M_2; 6 upper molars; 2 upper incisors.

REMARKS: Largely confined to upland forests of the state, the woodland jumping mouse does not occur at the site today.

Family Erethizontidae

Erethizon dorsatum (Linnaeus)—Porcupine

MATERIAL: CM 7998-8001. Four partial skulls; 1 left, 3 right mandibles. Isolated molars; incisors; 1 left humerus, 2 vertebrae; numerous fragmentary limb bones.

REMARKS: Not a member of the Recent fauna of York County, the porcupine is confined to the mountain forests of the state today.

Order Carnivora

Family Canidae

Canis sp.—Small wolf or dog

MATERIAL: CM 7997. One right humerus; 1 left, 1 right partial tibia; 1 partial left ulna.

REMARKS: The late date for the formation of the breccia makes Indian dog a distinct possibility. Compared with dog skeletal material from an early 17th-century Indian site in Lancaster County (Site No. 36-La-12 at Washington Boro) the bones are of comparable length and but slightly stouter.

cf. *Vulpes*, ?species probably Red fox

MATERIAL: CM 8007. One upper right canine.

Family Mustelidae

Mustela sp.—Small weasel

MATERIAL: CM 7987, CM 8006. One left M^1; 1 right P^4.

Mephitis mephitis (Schreber)—Striped skunk

MATERIAL: CM 7989-7991, CM 7993-7996. Five partial skulls; 4 left, 2 right mandibles; fragmentary limb bones; isolated canines.

Lutra canadensis (Schreber)—Otter

MATERIAL: CM 7988. One left mandible, full dentition.

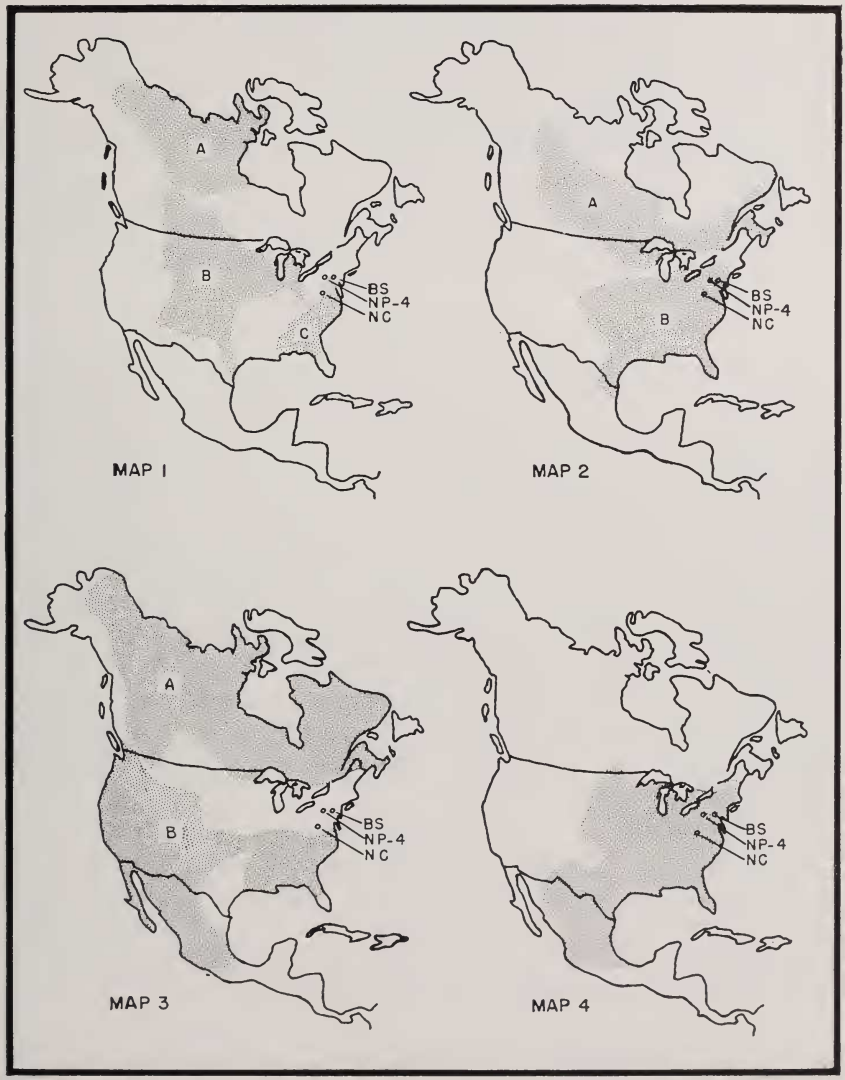

Fig. 4 Modern North American distribution of selected species from the Bootlegger Sink Local Fauna. BS = Bootlegger Sink, Pennsylvania. NP-4 = New Paris No. 4, Pennsylvania. NC = Natural Chimneys, Virginia. Map 1: A. *Microtus xanthognathus,* B. *Citellus tridecemlineatus.* C. *Lampropeltis calligaster rhombomaculata.* Map 2: A. *Sorex arcticus.* B. *Cryptotis parva.* Map 3: A. *Rangifer tarandus.* B. *Plecotus.* Map 4: *Sylvilagus* (*floridanus* plus *transitionalis*).

Order Artiodactyla
Family Cervidae

Odocoileus virginianus (Zimmermann)—White-tailed deer

MATERIAL: CM 8008. Two ungual phalanges, 1 second phalanx; fragments of metatarsal, ilium, femur, distal metapodial epiphysis.

Rangifer cf. *tarandus* (Linnaeus)—Caribou

MATERIAL: CM 7986. One right cuneiform; 1 right unciform; 1 ungual phalanx; 1 accessory phalanx.

REMARKS: Caribou remains are scarce from Pleistocene deposits in the East. They have been reported from only one other site in the state: Hartman's Cave, Monroe County (Leidy, 1889). See fig. 4, map 3A for modern range.

Discussion

The Bootlegger Sink local fauna is mixed both chronologically and ecologically. Based upon modern habitat requirements it is impossible to imagine that all the species recovered from the breccia deposit were contemporaneous. It is unrealistic to visualize a situation in which the least shrew (*Cryptotis parva*) (fig. 4, map 2B) and the cottontail rabbit (*Sylvilagus*) (fig. 4, map 4) could co-exist with the yellow-cheeked vole (*Microtus xanthognathus*) (fig. 4, map 1A) and the arctic shrew (*Sorex arcticus*) (fig. 4, map 2A). The wide range of fluorine values calls for a long period of accumulation. The C^{14} date provides a minimum date for the brecciation that is well within Recent times. Except for numerous, unidentified fungus spores the pollen analysis was negative. On the basis of the present evidence, deposition began during late glacial times, 10,000 to 15,000 years ago, and continued to the period of brecciation, 3000 to 4000 years ago.

A stratigraphic key to small mammal successions during the late glacial period in the central Appalachians is provided by the New Paris No. 4 local fauna, about 200 miles west of Bootlegger Sink and 1200 feet higher. Using this fauna as an indicator of late glacial changes, and the modern fauna of York County as indicative of the Recent past, the Bootlegger Sink local fauna could be separated as follows:

TABLE 1

PROBABLE CHRONOLOGICAL DISTRIBUTION OF MAMMALS FROM THE BOOTLEGGER SINK BRECCIA

Species	Late Glacial *ca.* 8000 B.C. (cold fore-glacial climate)	Hypsithermal *ca.* 3000 B.C. (period of maximum warmth)	Recent *ca.* 1758 A.D. (modern climate)
Parascalops breweri	P	-	-
Condylura cristata	P	P	P
Cryptotis parva	-	P	P
Blarina brevicauda	P	P	P
Microsorex hoyi	P	?	?
Sorex arcticus	P	-	-
Sorex cinereus	P	P	P
Pipistrellus	?	P	P
Eptesicus	P	P	P
Plecotus	-	P	-
Myotis cf. *keenii*	P	P	P
Myotis cf. *lucifugus*	P	P	P
Tamias striatus	P	P	P
Marmota monax	?	P	P
Citellus tridecemlineatus	P	-	-
Tamiasciurus hudsonicus	P	P	P
Sciurus	-	P	P
Glaucomys volans	-	P	P
Glaucomys sabrinus	P	-	-
Peromyscus cf. *leucopus*	-	P	P
Peromyscus cf. *maniculatus*	P	-	-
Synaptomys borealis	P	-	-
Clethrionomys gapperi	P	-	-
Microtus pennsylvanicus	P	P	P
Microtus chrotorrhinus	P	-	-
Microtus xanthognathus	P	-	-
Pitymys pinetorum	-	P	P
Napaeozapus insignis	P	-	-
Erethizon dorsatum	P	-	-
Sylvilagus, sp.	-	P	P
Vulpes	P	-	-
Canis (dog ?)	-	P	P
Mustela sp.	P	P	P
Lutra canadensis	P	P	P
Mephitis mephitis	?	P	P
Rangifer cf. *tarandus*	P	-	-
Odocoileus cf. *virginianus*	-	P	P

P=present
-=absent

Assignment of species to the Late-Glacial, Hypsithermal and sub-Recent is based upon the known faunas of Late-Glacial (New Paris No. 4), Hypsithermal (Sheep Rock Shelter, in part, Guilday and Parmalee, 1965) and sub-Recent (various archeological) sites in the state. (Guilday, Parmalee and Tanner, 1962). The Late-Glacial climate was boreal, quite different from the warmer Hypsithermal and sub-Recent. The Hypsithermal is believed to have been somewhat warmer and drier than at present.

If the period assignments are correct, and some are admittedly speculative, 35 per cent of the Bootlegger mammalian fauna (13 species) was deposited during the Late-Glacial period, 2.7 per cent (1 species) during Hypsithermal times, and 24 per cent (9 species) during the sub-Recent. The remaining 38 per cent (14 species) could have been deposited at any time from the Late- Glacial onwards.

The Bootlegger Sink local fauna is important in that it demonstrates that boreal forms now restricted to high latitudes or altitudes ranged during Late-Glacial times into the Piedmont of the eastern seaboard. Heretofore, all known cave sites producing boreal Pleistocene faunas had been confined to either the Ridge and Valley province, or the Appalachian/Cumberland Plateau region of the midwest. This is the second record of the caribou from Pennsylvania. The presence of the thirteen-lined ground squirrel in the deposit demonstrates that at least some nominally western forms reached the Atlantic seaboard during the Late-Glacial.

It also documents two northerly range extensions. The mole snake (*Lampropeltis c. rhombomaculata*) (fig. 4, map 1C) and the long-eared bat (*Plecotus* sp.) (fig. 4, map 3B) both extended their ranges north possibly one hundred miles. This is probably associated with the warm, dry Hypsithermal Interval (*ca.* 3000 B.C.).

Only a small section of the bone-bearing breccia was examined. If the site is excavated as planned by a joint North Museum-York Grotto, National Speleological Society group, more of the post-glacial history of the cave and of the York County area will be learned from the tons of matrix still remaining in Bootlegger Sink.

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